

MRS 1997 SPRING MEETING
SYMPOSIUM D:
GALLIUM NITRIDE AND RELATED MATERIALS

A CHEMICAL AND STRUCTURAL STUDY OF THE
AlN-Si INTERFACE

R. Beye*, T. George

Center for Space Microelectronics Technology, Jet Propulsion Laboratory, California
Institute of Technology, Pasadena, CA 91109

*Robert.W.Beye@JPL.NASA.Gov

J.W. Yang, M.A. Khan

APA Optics Inc., 2950 N.E. 84th Lane, Blaine, MN 55434

The growth of low defect density heteroepitaxial AlN has great implications for optoelectronic and high power devices since the AlN can be used either as device material or as a buffer layer for the overgrowth of other group III-Nitrides. Silicon substrates are particularly attractive for the growth of AlN when considering cost, defect density, available sizes, ease of etching and cleaving and finally the possibility of incorporating III-N devices in VLSI circuits. The current limitations of AlN/Si crystalline quality may stem from interactions occurring at the AlN-Si interface during nucleation, observed in this study using transmission electron microscopy, whereby incipient AlN interfacial regions are misaligned with respect to the substrate. These mis-alignments, witnessed both in and out of the AlN basal plane, are accompanied by a thin amorphous-like region at the Si interface. These amorphous regions have been reported previously and are believed to be a particular feature of III-N/Si growth. Their elimination would be beneficial for subsequent epilayer growth.

Ideally, close-packed planes and directions of the abrupt silicon [111] substrate surface are matched by equivalent planes and directions in the hexagonal AlN epilayer. Differences in lattice parameter can be accommodated by misfit dislocations without changing this orientation relationship. Chemical interactions, especially those resulting in amorphous compound formation, disrupt this epitaxial relationship and should be eliminated if high-quality group III-nitrides are desired. The presence of high concentrations of Si in AlN has been reported in the vicinity of the Si substrate, at distances equal to the thickness of the amorphous region. The affinity of Si for N is reflected in the stability of silicon nitride, which would provide the amorphous template for the observed effects. Furthermore, Si-N interfacial bonding has been reported for heteroepitaxial AlN layers grown on SiC substrates.

In this work, the results of transmission electron microscopy (TEM) involving both high resolution imaging and electron energy loss spectroscopy (EELS) of AlN/Si layers is reported and the relationship between Si-Al-N interactions and the *lattice*-orientation of AlN nuclei is elucidated.